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[54] **FLEXIBLE OVAL DUCT FOR HEATING AND COOLING SYSTEMS AND METHOD SUCH DUCTS**

[76] Inventor: **Theodore Primich**, 2700 E. 5th Ave., Gary, Ind. 46402

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[52] U.S. Cl. .... **138/133; 138/144; 138/154**

[58] Field of Search ..... 138/129, 133, 138/127, 121, 144, 154

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Primary Examiner—James Hook

Attorney, Agent, or Firm—Marshall A. Burmeister

## [57] ABSTRACT

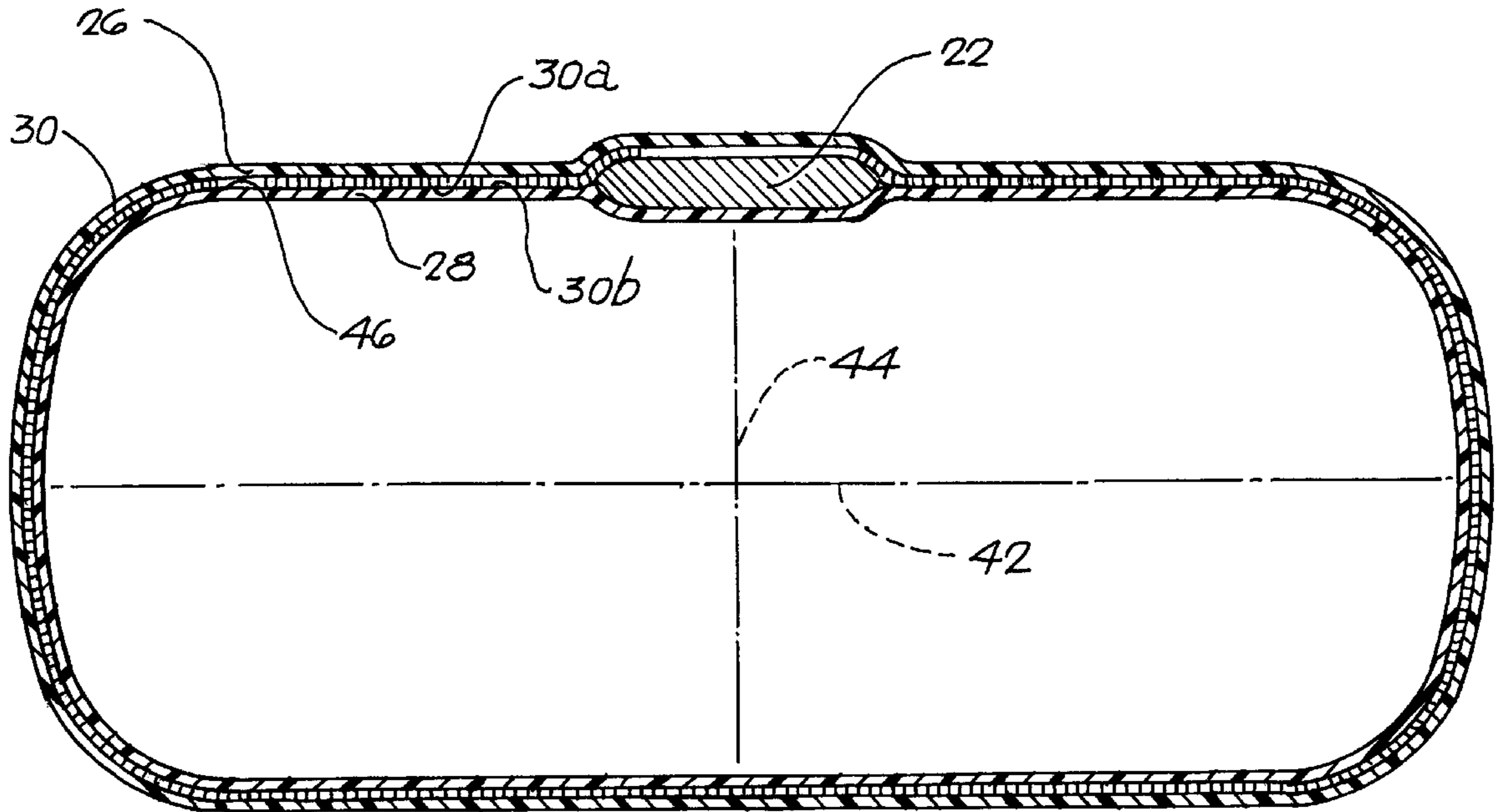
A flexible duct for use in a heating or cooling system having an elongated wire cemented between two elongated plastic ribbons and wound into a multi-turn coil, a portion of the plastic ribbons of each turn overlapping and being cemented to a portion of the plastic ribbons of adjacent turns to form a duct, the wire forming a plurality of identical turns with each turn having a pair of U-shaped end portions and a pair of elongated portions, the elongated portion being interconnected by an end portion and being aligned with the elongated portions of adjacent turns. A method of making such duct and apparatus for making such duct are also disclosed.

**9 Claims, 5 Drawing Sheets**

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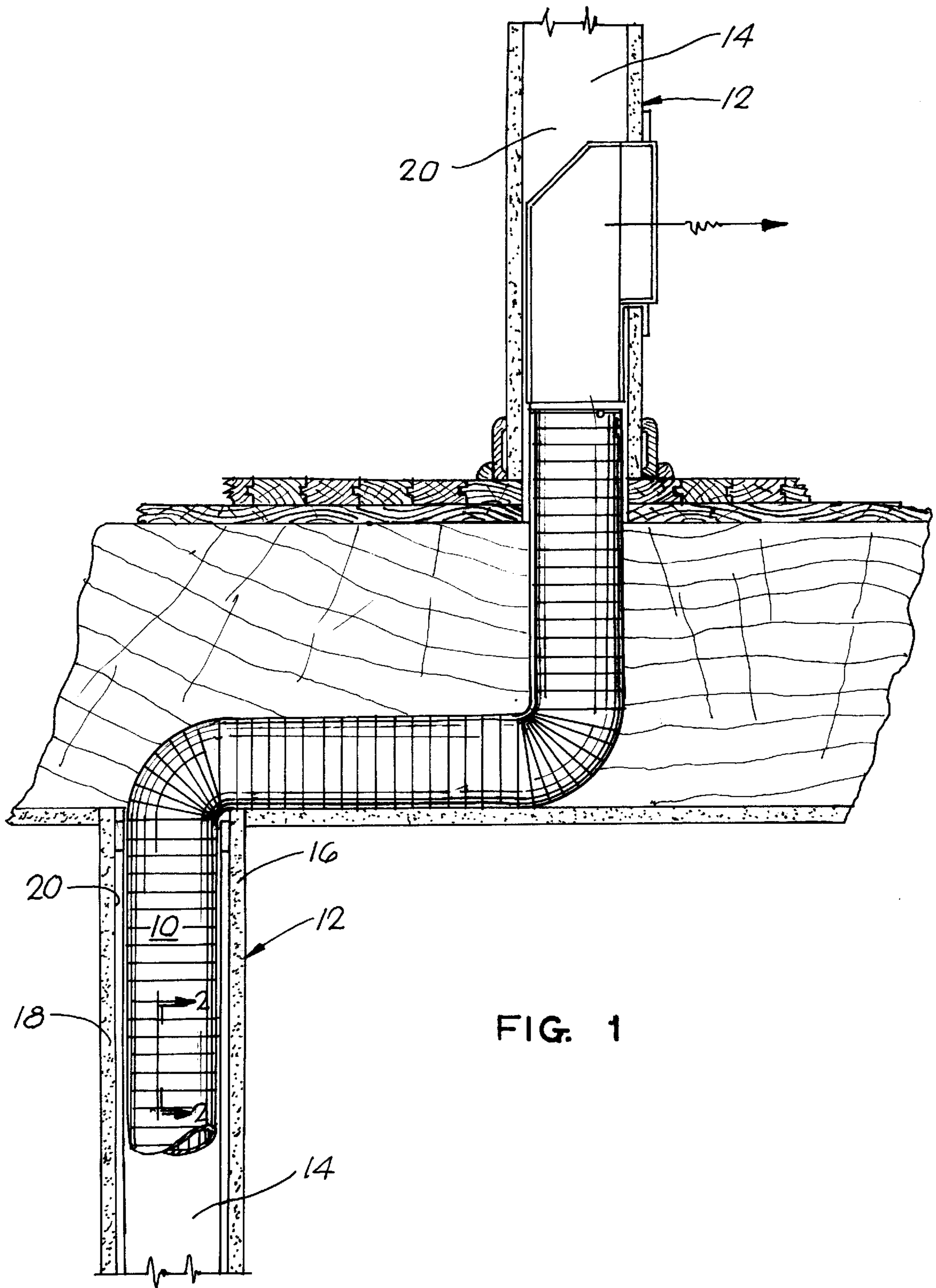


FIG. 1

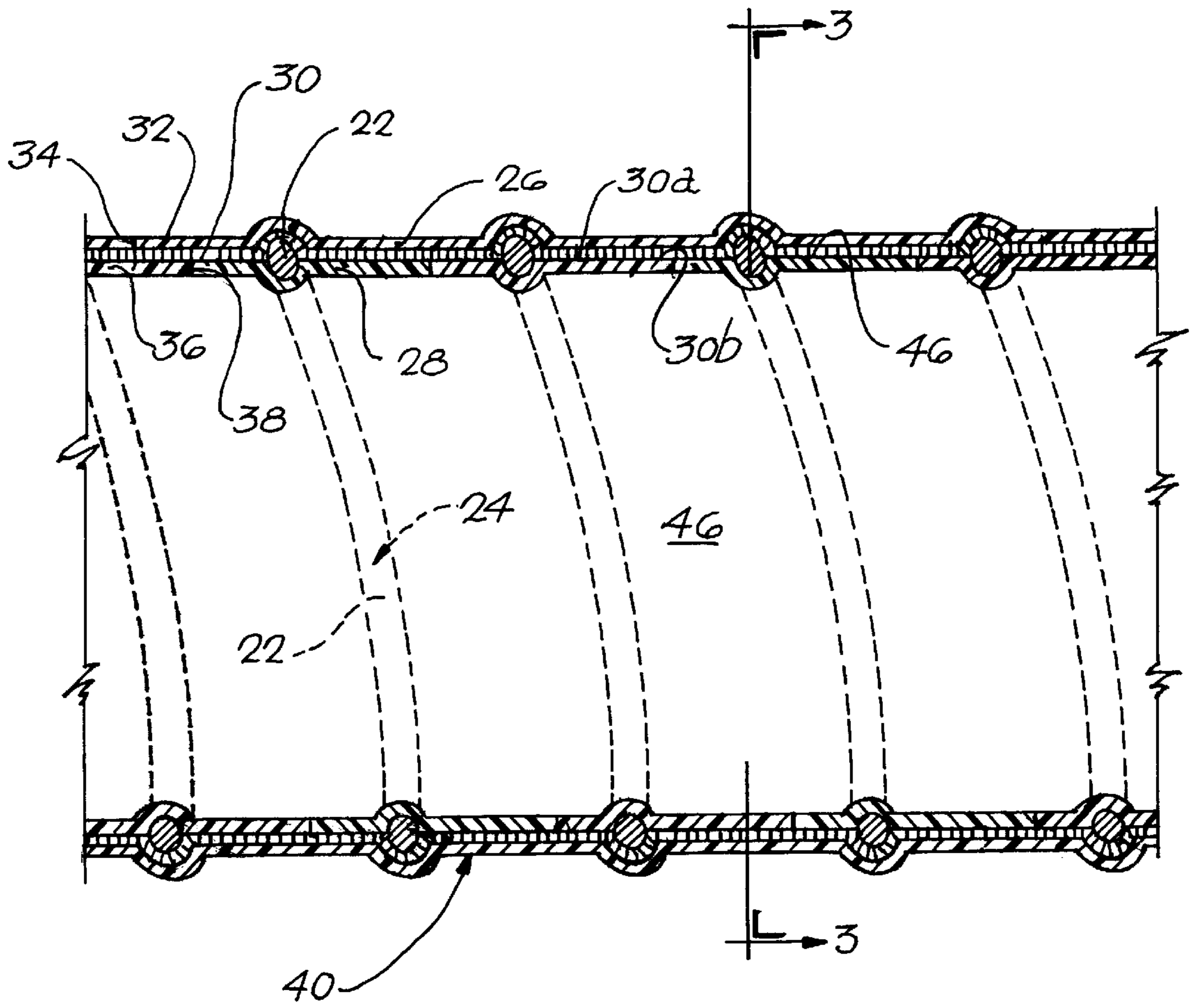


FIG. 2

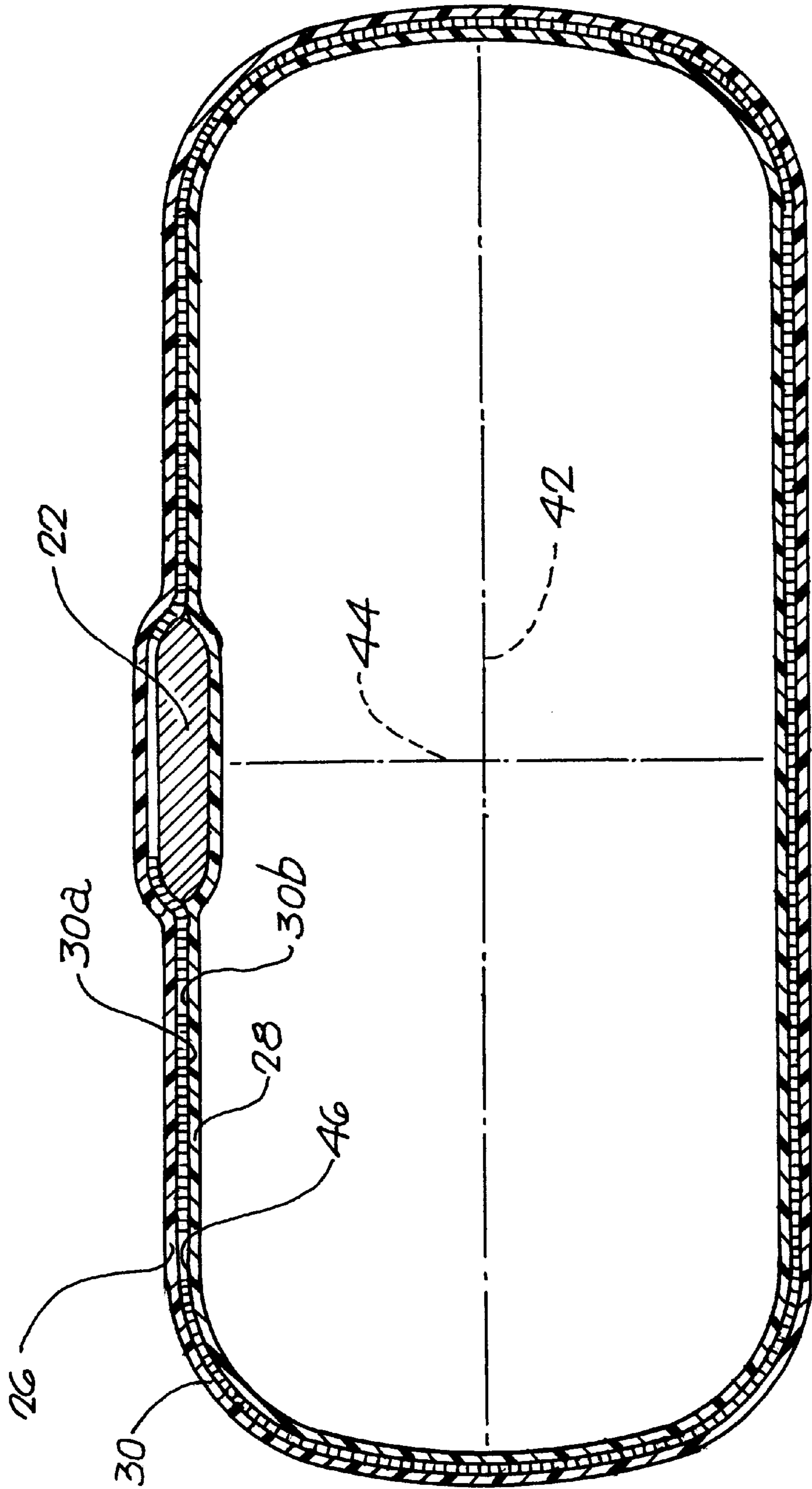


FIG. 3

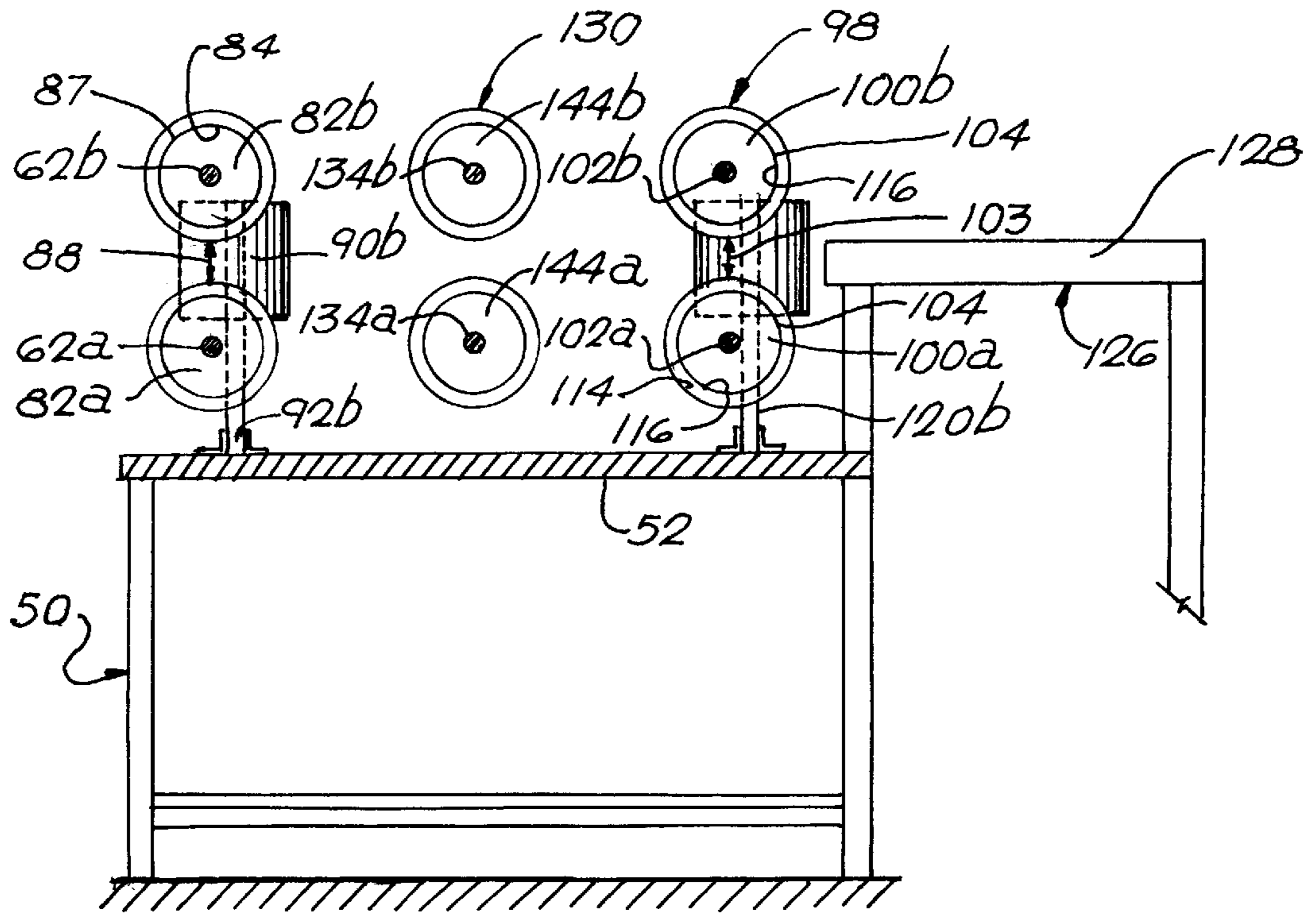


FIG. 6

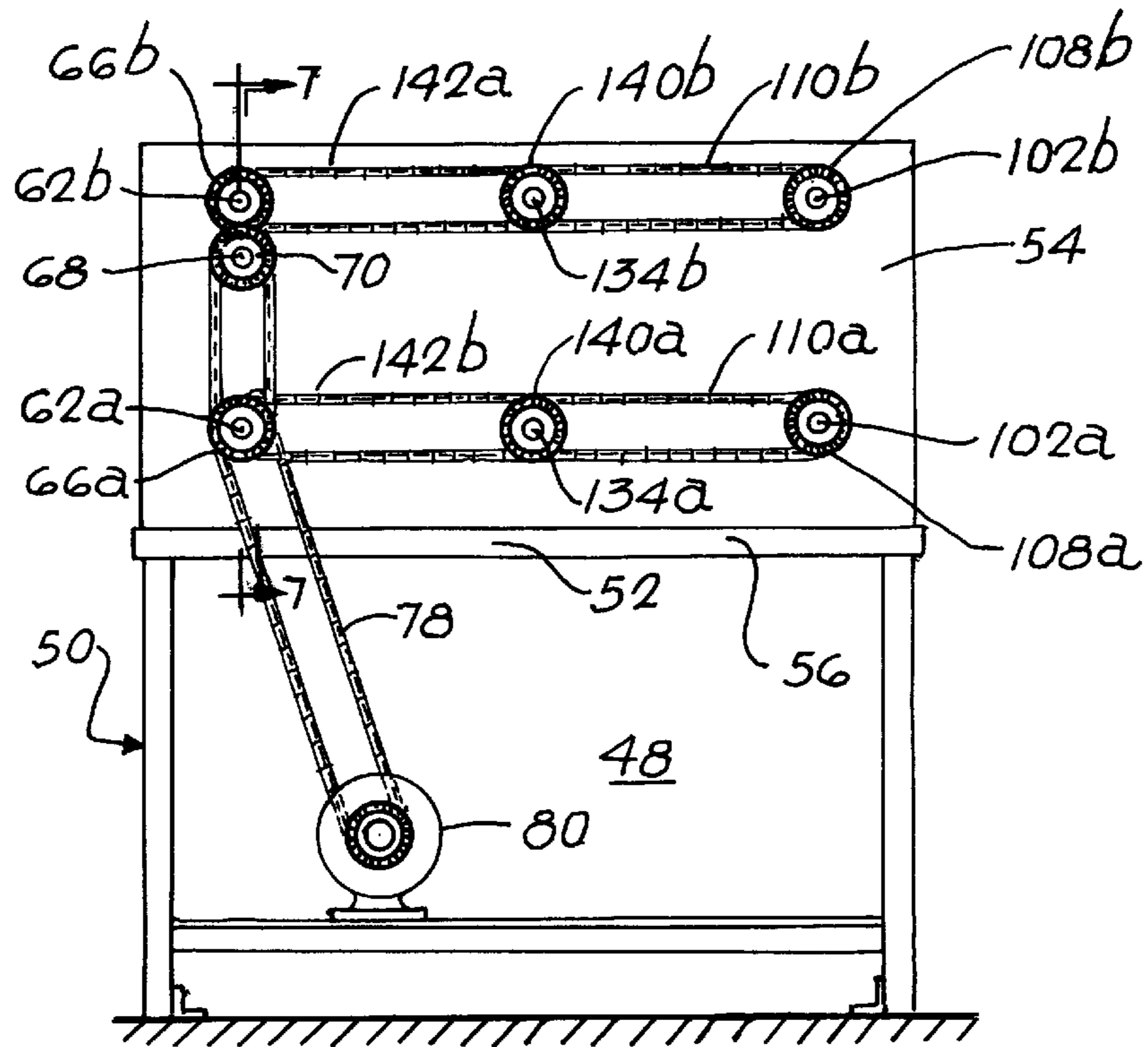


FIG. 4

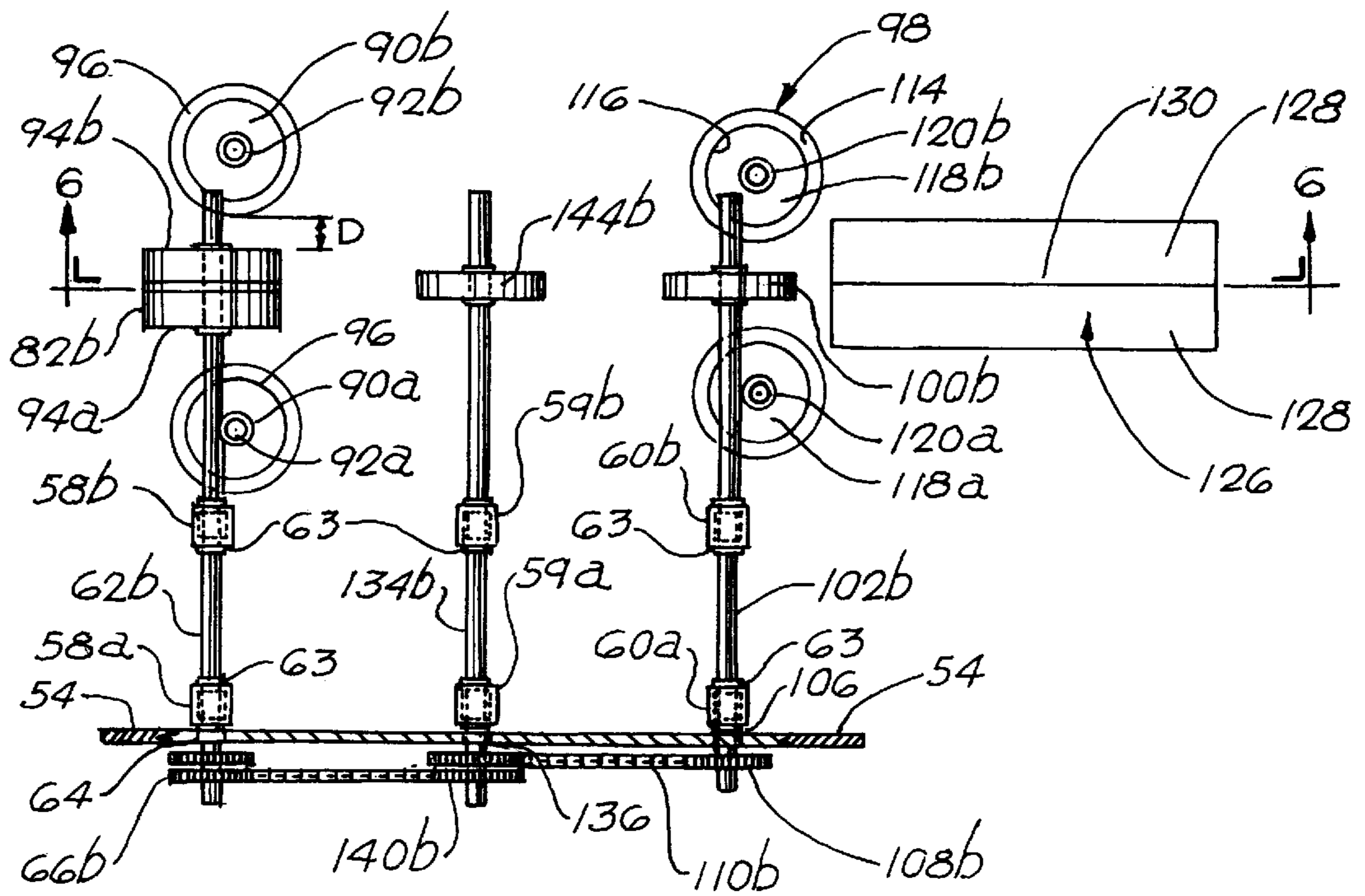


FIG. 5

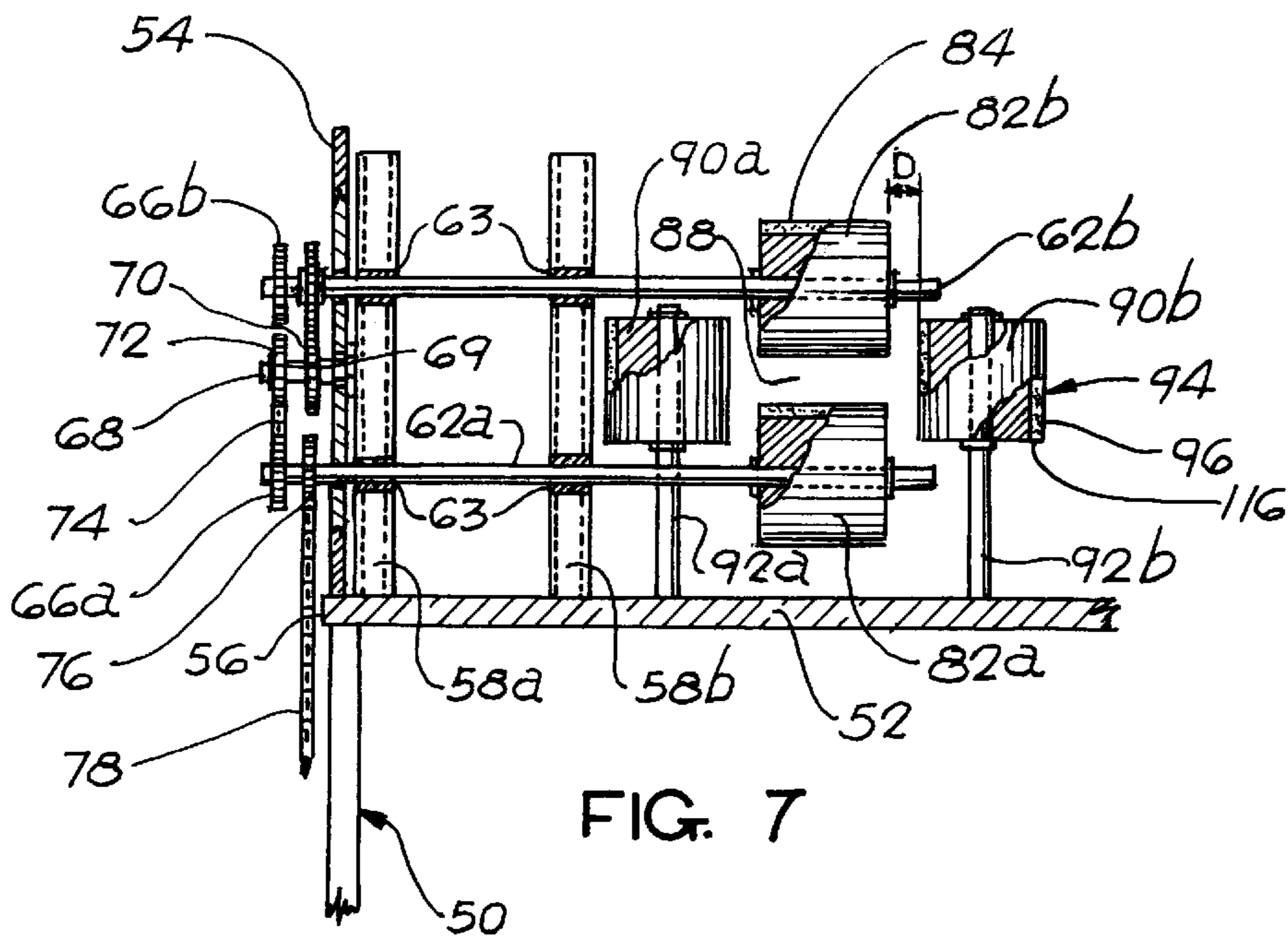


FIG. 7

## FLEXIBLE OVAL DUCT FOR HEATING AND COOLING SYSTEMS AND METHOD SUCH DUCTS

The present invention relates to ducts for transporting air in heating, cooling and ventilating systems for controlling the environment within structures and isolated regions thereof, and to methods of making such ducts. More particularly, the present invention relates to ducts for transporting air in heating, cooling and ventilating systems in and through the walls of buildings, and to methods of making such ducts.

### BACKGROUND OF THE INVENTION

It is common practice in modern construction to provide a system for heating or cooling or ventilating a structure. Most installations utilize moving air for one or more of these functions, and it is common to either heat or cool the regions of a building to be temperature controlled with a system of ducts to transport temperature controlled air from a central heating or cooling source to the various regions to be heated or cooled.

In most recently constructed houses, the central heating or cooling source is either a hot air furnace or a coolant-to-air heat exchanger of a central cooling system, and in climates requiring both heating and cooling, both may be employed. Often, the central heating or cooling source is disposed in a basement of the house, or in a pit disposed in the ground beneath a ground-level floor of the house. The air from the source is transported under pressure to a plurality of register heads. The most economical way to transport the air flow in such structures is through ducts located beneath the floors, in the walls and above the ceilings of the structures.

A common practice in the United States is to construct walls using equally spaced vertical studs which support a layer of material on each of the opposite sides of the studs, such as plaster, plaster board, fiber board, particle board, or the like. This construction provides open channels between the studs which are suitable for accommodating ducts for transporting air in heating or cooling systems. Because the studs are generally 4 or 6 inches thick and disposed on 16 inch centers, the cross section of the space between adjacent studs is rectangular, and with 4 inch studs, the maximum usable cross section of the wall channel is about 14 by 3½ inches.

In order to optimize the air flow through a duct in such a wall, substantially rigid rectangular ducts constructed of sheet metal have been employed. Such ducts are available commercially in 3½ inch thicknesses and various widths ranging to 14 inches, but the length of available sections are relative short, namely 24, 48, 60, 96 and 100 inches. The sections must be connected together to provide the proper length of duct for each installation, and since the duct is rigid, fittings such as elbows, and angles constructed of sheet metal must be used to provide bends between sections. The sheet metal ducts and fittings are relatively costly and require significant labor to install. Further, the installation must be skillfully completed to assure against leaks, vibration and other noises. Hence, an installation constructed in this manner is relatively costly.

Installations between adjacent studs have also been made using rigid oval sheet metal duct which reduces air flow noise and permits the use of duct with cross sections approaching those of rectangular duct. Spiral-Helix, Inc. of Buffalo Grove, Ill. is marketing a machine for converting rigid-cylindrical sheet metal pipe to oval pipe by stretching

the cylindrical pipe from the interior thereof to assume a flat oval shape. Such rigid oval pipe may be installed in the channels between studs in walls and will provide air moving capacity under these conditions significantly greater than a cylindrical duct of the diameter of the studs and approaching the air moving capacity of rectangular duct, but it, like rigid rectangular duct, requires skilled installation and sheet metal fittings to achieve bends, thus retaining the cost disadvantages of rectangular duct.

Further, all rigid duct has the disadvantage of requiring relatively large cartons for storage and shipment, and in order to reduce the size of the cartons, such rigid duct is constructed in relatively short sections. The large cartons add to the cost of storage and shipment, and the short sections add to the cost of installation.

The inventor has recognized that a reduction in the cost of materials and installation could be achieved by using flexible oval or rectangular duct, but such a duct is not commercially available. U.S. Pat. No. 3,216,459 granted on Nov. 9, 1965 to C. A. Schroeder and O. L. Clark entitled *Flexible Insulated Duct* does disclose a generally rectangular flexible duct which comprises an inner generally rectangularly shaped wire coil surrounded by one or more layers of thermal insulating material and an outer plastic sleeve. The duct of this patent does not have a flexible inner plastic tube which is supported by the wire coil. Further, the duct of the patent lacks a vapor barrier which is generally required in modern heating, cooling or ventilating systems. In addition, the duct of this patent is limited in length to the length of the collapsible mandrel used in its production.

### SUMMARY OF THE INVENTION

The principle object of the present invention is to provide a flexible duct for heating, cooling or ventilating systems which overcomes the disadvantages of the prior art. Thus, the general object of the present invention is to provide a duct which is less costly to construct than rigid duct, does not require fittings for achieving bends in installations, is less costly to install, does not require the skill for installation that is required for rigid duct, may be packaged in smaller containers than rigid duct for storage and shipment, and has the same or greater air flow capacity when installed in the walls of a building than the rigid duct known to the prior art. More specifically, it is an object of the present invention to provide a flexible duct with an oval cross section suitable for use in transporting air in a heating, cooling or ventilating system, and a method for producing such duct.

Several years ago, the inventor developed a process for making a flexible duct with a circular cross section which is suitable for transporting air in a heating, cooling or ventilating system and a process for producing such flexible round duct in sections of unlimited length. This duct is produced by winding two elongated ribbons of thin flexible plastic and a resilient wire on a rotating mandrel, cementing the ribbons and wire together on the mandrel, and slipping each completed turn from the mandrel as the following turn is being produced. In the finished product, the wire is cemented between the two ribbons to form a single elongated strip, and the strip is wound into a multiturn coil. Each turn of the elongated strip has edges overlapping the edges of adjacent turns, and the overlapping edges are cemented together to form an air impermeable elongated tube. The wire assumes the shape of a helix and provides the rigidity to maintain the shape of the elongated flexible duct. The wire is selected to have sufficient stiffness to prevent collapse of the duct under condition of service, and also to have

sufficient resilience to permit bending of the duct. In practice, the wire is made of high carbon, hard drawn spring steel, and the ribbons are of plastic. Such flexible duct is available commercially from Gary Steel Products Corp. of Gary, Ind. under the mark ZIPP-R FLEX.

The inventor perceived that flexible duct with an oval cross section, similar to the round flexible duct described above, could achieve the objects and advantages of the present invention, but flexible oval duct suitable for transporting air in a heating, cooling or ventilating system could not be manufactured by the known methods of the prior art and did not exist prior to the present invention. The process for producing flexible duct with a round cross section, described above, may not be readily modified to produce a flexible duct with an oval cross section, because of the complications which would be created by the use of a rotating oval mandrel. Reforming flexible duct with a circular cross section into oval duct by stretching the flexible duct from the inside using the machine of Spiral-Helix, Inc., described above, would require stretching of the plastic as well as the wire, which would be undesirable, and in addition would be limited by the length of the mandrel of the Spiral-Helix machine to relatively short sections of duct, thus making this process unsuitable. It is therefore a further object of the present invention to provide a wire reinforced flexible duct with an oval cross section and a process for making such wire reinforced flexible duct.

Further objects and advantages of the present invention will be apprehended from the following specification and the accompanying drawings, which may be described as follows.

#### DESCRIPTION OF DRAWINGS

FIG. 1 is a fragmentary sectional view of a building with an air heating/cooling installation constructed according to the present invention;

FIG. 2 is a fragmentary central longitudinal sectional view of the duct taken along line 2—2 of FIG. 1;

FIG. 3 is a sectional view of the duct taken along line 3—3 of FIG. 2;

FIG. 4 is a front elevational view of a machine for reforming a round flexible duct into an oval duct;

FIG. 5 is a plan view of the machine of FIG. 4;

FIG. 6 is a sectional view of the machine taken along the line 6—6 of FIG. 5; and

FIG. 7 is a fragmentary sectional view taken along line 7—7 of FIG. 4.

#### DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates a fragment of an air distribution system constructed according to the present invention installed in an otherwise conventional heating, cooling and ventilating system for a conventionally constructed house. The air distribution system employs duct **10** constructed according to the teachings of the present invention. The house has walls **12** constructed with a plurality of vertical studs **14** disposed at spaced equal intervals in a common plane. Typically, the studs **14** are nominally 2 inches by 4 inches and spaced at 16 inch centers. The studs **14** support wall panels **16** and **18** which are secured on opposite sides of the studs to complete the wall **12** and form a channel **20** between adjacent studs **14** and the attached wall panels **16** and **18**.

With this construction, each of the channels **20** has a rectangular cross section of about 14 inches by 4 inches, or

about 56 square inches, which is greater than the cross sectional area of an 8 inch round duct. Since a 6 inch round duct, with about one-half of that cross sectional area, will generally deliver sufficient air for such installations, the area of each channel **20** is more than sufficient to contain the air distribution ducts of such an installation. In the preferred construction here described, the duct **10** is oval in cross section and has an axis of elongation of about 7½ inches and a transverse axis of about 3¼ inches.

The duct **10** is illustrated in FIGS. 2 and 3, and is formed with a wire **22** which has a permanent set in the form of a coil with a plurality of turns **24**, each turn **24** being in the configuration of an oval. The wire is constructed of resilient material, such as carbon spring steel. The wire is disposed between an outer ribbon **26** and an inner ribbon **28** of substantially air impermeable flexible material, and a layer **30** of cement is disposed between the ribbons **26** and **28** and between each of the ribbons **26** and **28** and the wire **22**. The ribbons **26** and **28** are of the same width, and the ribbons **26** and **28** are wound into an elongated air impermeable tube, designated **40**. In the preferred construction, a narrow portion **32** of the outer ribbon **26** adjacent to leading edge **34** of each turn overlaps a narrow portion **36** at the trailing edge **38** of the adjacent turn. The layer **30** of cement is formed by a first coating **30a** substantially covering the entire inner surface of the outer ribbon **26** and a second coating **30b** substantially covering the entire outer surface of the inner ribbon **28**, and hence the layer **30** of cement extends between the portions **32** and **36** to interconnect adjacent turns.

The flexible ribbons **26** and **28** are not self supporting and are supported by the coil of wire **22** as an elongated tube **40**. As illustrated in FIG. 3, the cross section of each turn **24** of the coil of wire **22** is oval, and accordingly, at each turn **24**, the cross section of the coil formed by the tube **40** of ribbons **26** and **28** and wire **22** is also oval. Each turn **24** of the wire coil has an axis of elongation **42** and a transverse axis **44**, and the permanent set of the wire **22** positions these axes for all turns parallel to each other. However, because the wire is relatively thin and resilient, it may readily be bent to position the axes of the turns in any desired relationship, but the resiliency of the wire tends to return the turns to the permanent set of the wire **22** unless restrained.

Further, the ribbons **26** and **28** provide a limit on the distance that adjacent turns **24** of the wire may become spaced from each other, and therefore a limit on the longitudinal expansion of the duct **10**. The spacing between adjacent turns of the wire coil also facilitate making sharp bends in the duct **10** in that the longer the spacing the fewer turns that are required to make any specific bend. The maximum spacing between adjacent turns also determines the amount of sagging of the ribbons **26** and **28** into the duct **10**, and shorter spacing of the turns is desirable to minimize sagging. In a preferred construction, the ribbons **26** and **28** have widths of 1<sup>25</sup>/<sub>32</sub> inches and the wire turns **24** have maximum spacings between adjacent turns of about 1½ inches.

The ribbons **26** and **28** are formed of clear transparent plastic, and a coating **46** is disposed on the interior surface of the outer ribbon **26** in order to reflect heat inwardly from the air flowing through the duct and provide a vapor barrier to maintain moisture within the duct. In the preferred construction, the plastic ribbons **26** and **28** are about 0.0006 inch thick and of polyester plastic. The ribbon **26** is provided with an aluminum coating **46** on its inner surface. In this preferred construction, the wire **22** is round and constructed of galvanized coated, high carbon, hard-drawn spring steel. The wire **22** has a diameter of about 0.044 inch. As stated



above, the duct **10** has a axis of elongation of about  $7\frac{1}{2}$  inches and a transverse axis of about  $3\frac{1}{4}$  inches.

In producing an oval duct according to the present invention, the aluminum reflective coating **46** is applied to the surface of the ribbon **26** which will become the inner surface thereof, and thereafter the inner aluminum coated surface of the elongated plastic ribbon **26** and the outer surface of the ribbon **28** are coated with cement. Thereafter, a round tube of the elongated ribbons **26** and **28** and wire **22** is formed on a cylindrical mandrel with overlapping edges cemented together to form an elongated duct of circular cross section and any desired length. Processes for producing round flexible duct suitable for use in heating, cooling or ventilating systems are in commercial use and disclosed in several United States patents, namely, U.S. Pat. No. 4,104,097 to Raymond A. Gregory and DeWitte Clifford Wilcox; U.S. Pat. No. 4,299,641 to Walter F. Kelly; and U.S. Pat. No. 4,459,168 to Anthony C. Anselm, and these processes may be used to produce the round flexible wire supported tube.

The next step in producing an oval duct according to the present invention is to reform the circular duct described above into an oval duct. FIGS. 4 through 7 illustrate a machine, referred to herein as a reformer and designated **48**, for reforming the round flexible duct described above to establish a new permanent set for the coil of wire **22**, the new permanent set configuring each turn of the coil into a generally oval shape.

As illustrated in FIG. 4, the reformer **48** has a stand **50** which is provided with a generally horizontal table **52**. A plate **54** extends upwardly from one edge **56** of the table **52**. Three pairs of posts **58a** and **58b**, **59a** and **59b**, and **60a** and **60b** are mounted on and extend upwardly from the table **52**, each pair being disposed in a plane normal to the table **52** and plate **54**. One of the posts **58a**, **59a** and **60a** of each pair is disposed adjacent to the plate **54**, and the posts of each pair are spaced from each other by the same distance.

A first pair of shafts **62a** and **62b** are journaled on the first pair of posts **58a** and **58b** within bearings **63** mounted on the posts **58a** and **58b**, the shafts being disposed horizontally and spaced from each other in a plane normal to the table **52**. The shafts **62a** and **62b** extend through apertures **64** in the plate **54**, and a pair of gears **66a** and **66b** are mounted on the portions of the shafts protruding from the side of the plate **54** opposite the pair of posts **58a** and **58b**, respectively, the gears being rotatable with the shafts **62a** and **62b**. A stud **68** is rotatably mounted on the plate **54** by a bearing **69** between the gears **66a** and **66b**, and a reversing gear **70** is mounted on the stud **68** for rotation therewith and engages the gear **66b** on shaft **62b**. A drive gear **72** is also mounted on the stud **68** for rotation therewith, and the drive gear **72** is coupled to the gear **66a** on the shaft **62a** by a chain **74**. As a result of this construction, the shafts **62a** and **62b** are interconnected to rotate in opposite directions, and the gear ratios have been selected to rotate the shafts **62a** and **62b** at the same rate, all gears being of the same diameter.

Shaft **62a** also carries a second gear **76** which rotates with the shaft **62a**, and the second gear **76** is connected by a chain **78** to a motor **80**. Power from the motor **80** is thus coupled to the shafts **62a** and **62b** to rotate them in opposite directions at the same rate.

Cylindrical rollers **82a** and **82b**, referred to as reformer rollers, are mounted coaxially on shafts **62a** and **62b**, respectively, for rotation therewith. The rollers **82a** and **82b** have cylindrical surfaces **84** which confront each other and are spaced from each other by a distance substantially less than the diameter of the round flexible duct to be reformed

and somewhat less than the transverse axis of the oval duct to be produced. Further, the surfaces **84** of the rollers **82a** and **82b** are provided with a no-slip covering or layer **86** secured to the cylindrical surfaces of the rollers, as by a layer of cement **87**, and the distance between the confronting surfaces of the layers **86** is referred to herein as the gap **88**.

The inventor has attempted to reform round flexible duct into oval duct by introducing the round duct into the gap **88** between the rotating rollers **62a** and **62b** of the apparatus described above and compressing the helical coil of wire **22** to assume an oval shape, but such attempts proved unsuccessful for two reasons, namely, it was difficult to maintain the round duct in proper alignment with the rollers **82a** and **82b**, and even if proper alignment was maintained, the bends between the elongated portions of each turn of the coil of the flexible duct became too sharp, thus reducing the capacity of the duct beyond that of the desired oval shape.

The inventor found that both of the foregoing problems were substantially reduced by the addition of a pair of drums **90a** and **90b** journaled for free rotation on shafts **92a** and **92b** which extend vertically from the table **52** on opposite sides of the rollers **82a** and **82b**. The drums **90a** and **90b** also have cylindrical surfaces **94** which are covered with a no-slip layer **96**, and the inventor seeks to position the layers **96** to confront each other on opposite sides of the gap **88** between the rollers **82a** and **82b**, but the plane of the drums **90a** and **90b** must be positioned forward of this position to permit the shaft **92a** to pass to the side of shaft **62a**. The drums **90a** and **90b** are not powered but are free to rotate about the shafts **92a** and **92b**, and the surfaces of the layers **96** on the drums **90a** and **90b** are spaced from each other by a distance less than the desired longitudinal axis of the oval duct to be formed.

In operation, the roller **82a** rotates counterclockwise and the roller **82b** rotates clockwise. The drums **90a** and **90b** are effective in centering the duct to be reformed into the gap **88** between the rollers **82a** and **82b**. In addition, however, the drums **90a** and **90b** limit the elongation of the turns of the coil of the duct being reformed, and thereby force a more rounded U-shaped bend at each end of the longitudinal axis of each turn of the coil of the wire **22**.

The distances (D in FIG. 5) between the one end **94a** of the rollers **82a** and **82b** and the confronting surface of the drum **90b**, and the distances between the other end **94b** of the rollers **82a** and **82b** and the confronting surface of the drum **90a**, are important to the process of reforming the bends at the ends of the axes of elongation **42** of the turns **24** of the wire **22** of the duct **10**. At the moment of contact of the reformer rollers **82a** and **82b** with the duct to be reformed, the rollers **82a** and **82b** reform the wire turn in the gap **88** to form two confronting elongated portions with substantially straight permanent sets. At the same time, the confronting end portions of the turn engage the drums **90a** and **90b** and are placed under pressure across the distance D, hence resulting in two bends at each end of the axis of elongation of the turn, the two bends forming the U-shaped end portions of each turn. The inventor has found that best results are obtained if the distances D between the ends **94a** and **94b** of the rollers **82a** and **82b** and the confronting surfaces of the drums **90a** and **90b** are approximately one-fourth of the minimum distance between the outer surfaces of the layers **96** on the drums **90a** and **90b**. In this preferred construction, the longitudinal axes of the rollers **82a** and **82b** is approximately one-half of the minimum distance between the outer surfaces of the drums **90a** and **90b**.

The inventor has also found that as each turn of the coil of the duct to be reformed enters the gap **88** and engages the

rollers **82a** and **82b**, the duct rotates slightly so that the turns of the wire coil of the reformed duct do not have a permanent set with the longitudinal axes of the oval duct in the same plane. To avoid this twisting of the duct, at least one and preferably two additional input stages are required.

The first input stage **98** is mounted on the table **52** at the input side of the reformer rollers **82a** and **82b**. A second pair of shafts **102a** and **102b** are journaled on the third pair of posts **60a** and **60b** within bearings **63** mounted on the posts **60a** and **60b**, the shafts being disposed horizontally and spaced from each other by the same distance as shafts **62a** and **62b** in a plane normal to the table **52**. The shafts **102a** and **102b** extend through apertures **106** in the plate **54**, and a pair of gears **108a** and **108b** are mounted on the portions of the shafts protruding from the side of the plate **54** opposite the pair of posts **60a** and **60b**, respectively, the gears being rotatable with the shafts **102a** and **102b**. The gears **108a** and **108b** are coupled by chain drives **110a** and **110b** to the shafts **62a** and **62b**, respectively. As a result of this construction, the shafts **102a** and **102b** rotate in opposite directions in synchronism with the shafts **62a** and **62b**.

Cylindrical rollers **100a** and **100b** are mounted coaxially on shafts **102a** and **102b**, respectively, for rotation therewith. The rollers **100a** and **100b** have cylindrical surfaces **104** which confront each other and are spaced from each other by a minimum distance or gap **103** substantially equal to the minimum distance between the cylindrical surfaces of the rollers **82a** and **82b**. The surfaces **104** of the rollers **100a** and **100b** are provided with a no-slip covering or layer **114** secured to the cylindrical surfaces of the rollers, as by a layer of cement **116**.

A pair of drums **118a** and **118b** are journaled for free rotation on shafts **120a** and **120b** which extend vertically from the table **52** on opposite sides of the rollers **100a** and **100b**. The drums **118a** and **118b** also have cylindrical surfaces **122** which are covered with a no-slip layer **124**, and layers **124** are positioned to confront each other on substantially opposite sides of the gap **103** between the rollers **100a** and **100b**, the plane of the drums **118a** and **118b** being slightly forward of the axial plane of the rollers **100a** and **100b**.

The outer surfaces of the layers **124** on the drums **118a** and **118b** are spaced from each other by a distance less than the minimum distance between the drums **90a** and **90b** of the former stage, but at least equal to the diameter of the circular duct before reforming, the distance being sufficiently short to cause the duct being formed to engage the drums **118a** and **118b** and center the duct in the gap **103** between the rollers **100a** and **100b**, but no longer than the transverse axis of the oval duct to be formed.

The purposes of the first input stage **98** are to guide the round duct to be reformed into the reformer rollers **82a** and **82b** with each turn **24** of the coil of wire **22** as close to the plane of the axes of the rollers **82a** and **82b** as possible, and to avoid twisting of the duct in the reforming process. The first input stage **98** does not provide significant forming of the duct, and accordingly the rollers **100a** and **100b** have an axial length of about one-half of that of the rollers **82a** and **82b** of the reformer stage, i.e. about one-fourth of the distance between the drums **90a** and **90b**. Accordingly, the duct to be reformed is seized between the rollers **100a** and **100b** along what becomes the transverse axis of the duct and the tendency to twist is minimized. A V-shaped trough **126** is provided at the input side of the first input stage to facilitate proper alignment of the round duct into the rollers **100a** and **100b**. The trough **126** has a pair of flat panels **128**

extending upwardly from a central straight line interface **130** which is perpendicular to the plane of the axes of the rollers **100a** and **100b** and aligned with the intersection of the gap **103** and the surface of the roller **100a**.

While the duct being reformed may be passed directly from the first input stage **98** to the reformer rolls **82a** and **82b**, further reduction in the tendency for twisting the reformed duct can be achieved by a second input stage **130**. The second input stage **130** has a third pair of rollers **132a** and **132b**, referred to as input rollers, mounted on shafts **134a** and **134b** for rotation therewith. The shafts **134a** and **134b** are journaled in bearings **136** on posts **59a** and **59b**, and the shafts **134a** and **134b** extend through apertures **138** in the panel **54** to engage gears **140a** and **140b**, respectively. Chains **142a** and **142b** engages gears **140a** and **140b** and rotates the shafts **134a** and **134b**, respectively. A pair of rollers **144a** and **144b** are mounted on the shafts **134a** and **134b**, respectively, and rotate in the same directions as the rollers **100a** and **100b** of the first input stage **98** and at the same rate. The rollers **132a** and **132b** are identical to the rollers **100a** and **100b** and aligned therewith. The duct being reformed traverses the second input stage **130** as an extended and relatively stiff pipe due to the forward pull of the reformer rollers **82a** and **82b** and restraint placed on the duct by the operator during the process of feeding the round duct into the first input stage, and therefore it is not necessary to provide vertically mounted drums on opposite sides of the rollers **132a** and **132b** in the second input stage **130**, as was done in the first input stage **98**.

In operation, the operator introduces the open end of a round flexible duct onto the trough **126** and thereafter in to the gap **103** between the rollers **100a** and **100b** of the first input stage **98**, maintaining the first turn **24** of the coil of wire **22** of the open end of the duct as parallel to the plane of the rollers **100a** and **100b** as possible. Thereafter, duct being reformed will pass between the rollers **132a** and **132b** of the second input stage **130** to the reformer rollers **82a** and **82b**. The reformer rollers **82a** and **82b** then propel the duct being reformed forward placing the plastic outer tube under tension and stiffening the tube, thus maintaining the following turns **24** of the coil of wire in proper position for permanent set modification.

Those skilled in the art will devise many modifications of the duct and method of making duct disclosed herein within the scope of the invention. Further, those skilled in the art will find application for the devices and processes disclosed herein beyond those specifically described, but within the scope of the present invention. It is therefore intended that the scope of the present invention be not limited by the foregoing specification but only by the appended claims.

What is claimed is:

1. A duct for conducting pressurized air in a heating or cooling or ventilating system comprising an elongated resilient wire disposed in a coil consisting of a plurality of substantially identical turns, an elongated air impermeable flexible tube, said tube having an axial channel of uniform cross section extending along the axis of elongation of the tube, the circumference of the tube at the channel being approximately equal to the length of each turn of the wire coil, the wire coil being disposed coaxially of the flexible tube and the tube being attached to the coil, characterized by the improved construction wherein each turn of the wire coil consists of two elongated side portions and two end portions connected in a series, the side portions being substantially longer than the end portions and confronting each other, the side portions having opposite ends, one end of one side portion being connected to one end of the other side portion

by one end portion, and the other end of the one side portion being connected to the one end of the other end portion, each of the end portions having a permanent set in the form of a U-shaped bend, and the side portions of each turn of the wire coil confronting the side portions of adjacent turns of the wire coil.

2. A duct for conducting air in a heating or cooling or ventilating system comprising the combination of claim 1 wherein the tube is constructed of plastic.

3. A duct for conducting air in a heating or cooling or ventilating system comprising the combination of claim 2 wherein the tube is constructed of two ribbons of thin film and a layer of cement disposed between the ribbons, each of the ribbons having parallel opposed edges and a central axis of elongation, and the axes of elongation of the ribbons being aligned, the assembled ribbons being wound into a multiturn coil with a portion of the assembled ribbons disposed adjacent to the one edge of each turn of said assembled ribbons overlapping and being affixed to a portion of the adjacent turn of the assembled ribbons at the other edge of said adjacent turn to form the air impermeable tube.

4. A duct for conducting air in a heating or cooling or ventilating system comprising the combination of claim 3 wherein the wire of the coil is disposed between the ribbons and aligned with the axes of elongation of the ribbons, the assembled ribbons and wire being wound into the multiturn coil forming the air impermeable tube.

5. A duct for conducting air in a heating or cooling or ventilating system comprising the combination of claim 4 wherein the wire is constructed of spring steel.

6. A duct for conducting air in a heating or cooling or ventilating system comprising the combination of claim 1 wherein each turn of the wire coil has a transverse axis disposed normal to and centrally of the longitudinal axis thereof, and wherein the radius of curvature of the bends in each turn of the wire coil is no greater than one-half of the length of the central transverse axis of said wire turn.

7. A duct for conducting air in a heating or cooling or ventilating system comprising the combination of claim 6 wherein the wire in each turn of the coil has a permanent set between bends providing segments between bends which have a substantially straight configuration.

8. A duct for conducting air in a heating or cooling or ventilating system comprising the combination of claim 1

wherein the tube is constructed of two ribbons of thin flexible film and a layer of cement is disposed between the ribbons, each of the ribbons having parallel opposed edges and a central axis of elongation, and the axes of elongation of the ribbons being aligned and confronting each other, the wire of the coil being disposed between the ribbons aligned with the axes of elongation of the ribbons, the assembled ribbons and wire being wound to form a multiturn coil and the assembled ribbons and wire having a first portion extending from the one edge of each turn overlapping and being affixed to a second portion extending from the other edge of the adjacent turn, thereby forming the air impermeable tube.

9. A duct for conducting pressurized air in a heating or cooling or ventilating system comprising an elongated resilient wire disposed in a coil consisting of a plurality of substantially identical turns, an elongated air impermeable flexible tube, said tube having an axial channel of uniform cross section extending along the axis of elongation of the tube, the circumference of the tube at the channel being approximately equal to the length of each turn of the wire coil, the wire coil being disposed coaxially of the flexible tube, and each of the turns of said coil of wire being individually attached to the plastic tube along the entire length of the turn and at a common distance significantly greater than the cross section of the wire between adjacent turns of the coil, the turns of said coil of wire having sufficient stiffness to support the tube in the configuration of the coil, each turn of the wire coil being substantially identical and consisting of two elongated side portions and two end portions, the side portions being substantially longer than the end portions and confronting each other, the side portions having opposite ends, one end of one side portion being connected to one end of the other side portion by one end portion, and the other end of the one side portion being connected to the other end portion, each of the end portions having a permanent set in the form of a U-shaped bend, and the side portions of each turn of the wire coil confronting the side portions of adjacent turns of the wire coil.

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